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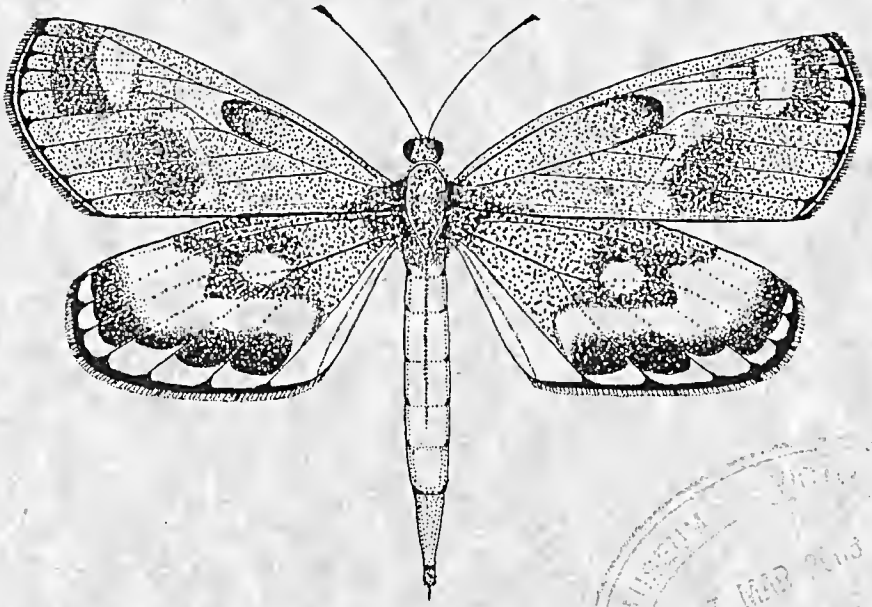

News Bulletin of The Entomological Society of Victoria Inc.

THE ENTOMOLOGICAL SOCIETY OF VICTORIA (Inc)

MEMBERSHIP

Any person with an interest in entomology shall be eligible for Ordinary membership. Members of the Society include professional, amateur and student entomologists, all of whom receive the Society's News r3 Bulletin, the Victorian Entomologist.

OBJECTIVES

The aims of the Society are:

(a) to stimulate the scientific study and discussion of all aspects of entomology,
(b) to gather, disseminate and record knowledge of all identifiable Australian insect species,
(c) to compile a comprehensive list of all Victorian insect species,
(d) to bring together in a congenial but scientific atmosphere all persons interested in entomology.

MEETINGS

The Society's meetings are held at 'InfoZone', Museum Victoria, Carlton Gardens, Melway reference Map 43 K5 at 8 p.m. on the third Friday of even months, with the possible exception of the December meeting which may be held earlier. Lectures by guest speakers or members are a feature of many meetings at which there is ample opportunity for informal discussion between members with similar interests. Forums are also conducted by members on their own particular interest so that others may participate in discussions.

SUBSCRIPTIONS

Ordinary Member	$20.00 (overseas members $22)
Country Member	$16.00 (Over 100 km from GPO Melbourne)
Student Member	$12.00
Associate Member	$ 5.00 (No News Bulletin)

Associate Members, resident at the same address as, and being immediate relatives of an ordinary Member, do not automatically receive the Society's publications but in all other respects rank as ordinary Members.

Cover design by Alan Hyman.

Cover illustration: The pale Sun Moth, *Synemon selene* Klug, is an endangered species restricted to perennial grassland dominated by *Austrodanthonia* in Western Victoria. It is now extinct in SA, and was presumed extinct in Vic. until its rediscovery, in February 1991, by the late Frank Noelker and Fabian Douglas. The Victorian Populations are parthenogenetic with all specimens comprising females, a most unusual trait in the Castniidae. Illustration by Michael F. Braby.

MINUTES OF THE GENERAL MEETING 17 JUNE 2005

Meeting opened at 8:02 pm

Present: P. Carwardine, D. Dobrosak, I. Endersby, P. Marriott, D. Meehan, D. Stewart, G. Weeks.

Visitors: J. Kissane, S. Mustoe, D. Rogers, G. Wright

Apologies: P. Meehan, K. Walker

Correspondence:
No correspondence was received.

Minutes: Minutes of the 15 April General Meeting [*Vic. Ent.* 35(1): 1] were accepted subject to G. Weeks being listed as present and D. Stewart as being an apology. M: Endersby, S: Weeks.

Treasurer's Report:
The Treasurer reported the account balances as: General account $6472: Le Souëf account $4,277.

Editor's Report:
The Editor reported that more articles were required.

General Business

- Andy Young and Dulto Marino were elected to Membership.
- Membership applications have been received from Peter Dixon and John Kissane
- The August General Meeting: Axel Kallies will present a talk on Day flying Lepidoptera.
- The October meeting will be an Excursion to View Laurie Cookson's collection at Warrandyte (more details Next issue)

Speakers:

Peter Carwardine: Methods of facilitation Breeding of lepidoptera that pupation in the ground.

Ian Endersby: Sperm Competition in Odonata

Daniel Dobrosak: Life History of Peltoschema rubiginosa and related species

[A summary of Peter and Ian's talk has been kindly provided by the authors. See this issue]

Meeting closed 9:33PM

MINUTES OF THE COUNCIL MEETING 15 JULY 2005

Meeting opened at 5:11 pm

Present: P. Carwardine, D. Dobrosak, I. Endersby, P. Marriott, A. Kellehear.,

Apologies: D. Stewart

Minutes of 20 May Council meeting. [*Vic. Ent.* 35(3): 43] were accepted. M: Carwadine, S: Endersby.

Correspondence:
No correspondence was received.

Treasurer's report
The Treasurer reported the account balances as: General account $7130: Le Souëf account $4,349.

The following motion was accepted: That $1,400 from the Le Souëf account and $2,600 from the General Account be moved into the term deposit when it is next due for renewal. The interest from the term deposit is to go to the Le Souëf account. M: Endersby, S: Dobrosak

16 members are still unfinancial. The Editor to send a final reminder. Additionally, unfinancial member's envelopes will be marked with red dots after the surname.

Editor's report
Only one article is in hand and more are needed. More envelopes are required and will be ordered by the Editor.

General Business:
Next meeting: Presentation on Day flying microlepidoptera (including new species of Brachodids a grassland/heathland dayflying moth closely related to sun moths- Castniidae) by Axel Kallies

Excursion to to view Laurie Cookson's collection. At 8pm Warrandyte Details to be in the next issue.

Closed 5:49 pm

EXCURSION. An excursion to a member's residence to view his collection will be held on the normal meeting night on 21st October. Any member wishing to go, and cannot transport themselves to Melway 23G12 (near Warrandyte Bridge) should contact Peter Carwardine 9571 8958 by 12/9/05.

Full details will be in October edition.

Breeding Moths that have Subterranean Pupation.

[A summary of the talk given at the June 2005 Member's Night.]

Under normal circumstances larva of these moths would burrow into the soil and pupate a few centimetres below the surface. Sometimes this is into fairly solid ground and the depth varies with the species and is probably tied in with larva size.
Over the years I have used various pupating mediums for breeding moths in captivity, but have avoided using soil as there may be various bacteria or fungi present that could cause some losses.

The pupating medium is put in a container suitable in area and depth for the size and quantity of larvae being bred. This can be anything available from cardboard boxes to jars or cut off part of a plastic bottle. After putting in the medium it will probably require tamping down to consolidate it, for small quantities, a piece of broomstick or such and a block of wood for large areas.

Pupating mediums I have used are :-
Rice Hulls which are useful for large larvae (unfortunately only available in large bags, but I was also using it as mulch)
Sphagnum Moss from nurseries etc, Rub between hands to break it up a bit.
Unprocessed Bran from supermarkets.
Many other materials would be suitable. However, I do not find that fine, light sand is suitable as the larvae have difficulty burrowing down.

Do not place larvae on the medium until they are ready to pupate, otherwise you will have droppings which need to be cleaned up to ensure that mildew does not become a problem. When you suspect the larvae are nearly full-grown, check them twice daily and if they appear to have ceased eating and are restlessly crawling around the breeding container, it is time to transfer them. If left too long in this condition they may become torpid and incapable of burrowing in and die. Place the larvae on the medium and put a cover on the container (lid on a jar, gladwrap & elastic on box). If not sure that the larvae have finished feeding, put some food with them. If a larva continues crawling instead of burrowing in, form a hole with the handle of an artist paint brush or pencil and nudge the head in. Put a label on the container with date of pupation and species name if known. A few days later place the container, without lid, in an emergence cage and leave it.

Some examples –
A dozen or so *Danima banksiae* (Banksia moth) larvae, c 60mm, in a cut down cereal box with 120 mm depth of rice hulls. A single larva, 30 mm, in a small jar 50 mm diam, with 50 mm bran flakes.
Many beetles also pupate underground, but I have no experience other than noting that *Paropsis* spp. will readily pupate on the bottom of the feeding container without any cover.

Peter Carwardine

Sperm Competition in the Odonata

[A summary of the talk given at the June 2005 Member's Night.]

Dragonfly mating commences when the male grasps the female with his legs and then clasps her by the prothorax (damselflies) or back of the head (dragonflies) with his anal appendages. This is known as the 'tandem' position. The male then transfers sperm to secondary genitalia on the ventral surface of his abdominal segments 2 and 3, after which the female forms the 'wheel' position by bending her abdomen so that her genitalia on segment 10 join the male's secondary genitalia. Sperm transfer occurs and the eggs can be fertilised.

Observations of the 'wheel' position showed that in some species it occurred in two stages recognised by a different orientation of the male's abdomen and frequency of pulsations. The first stage was very long, sometimes lasting hours, and the second very short. Dissection of mating pairs at various stages during copulation revealed that the shape of the male penis allowed either the removal of a prior male's sperm, or the displacement of it into the distal regions of the female bursa. This manipulation of prior sperm occurred in Stage 1 and the male's own insemination in Stage 2. Some species of male dragonflies thus achieve sperm precedence by sperm removal, sperm displacement, or sperm flushing (by using their own sperm to wash out that of a rival) and, finally, by mate guarding during oviposition to ensure that they are not pre-empted by a following male.

More recently it has been realised that females also have an incentive to maximise their genetic fitness. They can do this by the overt choice of a mate, or by rejecting an inferior male. Alternatively, they have evolved mechanisms to increase genetic diversity of their offspring by using multiple males' sperm or by giving priority to some sperm over others – a cryptic choice. There is, therefore, a sexual conflict between male and female, each trying to achieve sperm choice, and this leads to the equivalent of an 'arms race' where each protagonist makes a bigger bomb than its rival.

Females receive sperm into their bursa copulatrix and the male penis evolved to remove another male's sperm from this organ. Some females developed additional spermathecae which, because of their narrow spermathecal ducts, or ducts that are longer than male genital structures, did not allow the males access. Hence females could sequester particular male's sperm for fertilisation of the eggs.

Females have sensilla within their oviduct that trigger the release of sperm to fertilise an egg when it passes over it.

One male response to the inaccessibility of sperm within spermathecae was to displace spermathecal sperm by stimulating the female sensory system that coordinates the ejection of stored sperm during fertilisation. In effect, by the male simulating the passage of an egg, females ejected stored sperm as though they were fertilising that assumed egg. The wider the male aedeagus the more sperm was ejected.

In *Calopteryx haemorrhoidalis* females responded by reducing the number of sensilla thus ejecting less sperm, but continued reduction would compromise the fertilisation process
It should be recognised that the study of sperm competition in the Odonata:

- while it is the model for many subsequent studies in other taxa,
- it has only considered a few species from a restricted number of families
- no one species has all of the evolutionary adaptations described above
- the presumed responses in the arms race between male and female are purely for illustrating the types of behaviour and structures that have developed. They do not necessarily indicate an actual sequence.

Ian Endersby

Observations on Carrying Pair Behaviour among Asia-Pacific Butterflies: Part II (Personal Field Diary Records from 1999-2004)

Kelvyn L Dunn

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Summary: Forty-eight (48) mating observations involving 30 species of butterfly in the Asia-Pacific region, compiled since late 1999, are documented from the author's field diary. Carrier details, mating times, biological notes, and other factors documented in the field are included. Over half the mating observations are from eastern Australia (27), with regional others from Malaysia (1), Thailand (2), Laos (1), Taiwan (2), Micronesia (5), New Caledonia (5), Vanuatu (1), and Samoa (4). For the Asia-Pacific region, carrier-sex ratios are calculated for *Zizina labradus*, the genus *Zizina*, and the Polyommatinae. All ratios are subject to discussed limitations and vary according to methods of analysis. A male-biased, approximate ratio of 2:1 is accepted for this lycaenid subfamily:

Introduction

An absence of data on butterfly matings in Australasia, and few examples listed for the Oriental region in the world treatment by Shields and Emmel (1973) highlighted a gap in the knowledge base for the Asia-Pacific region. Subsequently Dunn (2000) provided 44 mating observations involving 30 species resident in the Australia-Pacific region and included some matings listed in recent Australian literature. This second list further alleviates the gap adding more mating observations on various butterflies from the same region. Although scattered records in the Asia-Pacific region exist in the literature either as descriptive or photographic evidence, these remain to be amalgamated in collative works, and are beyond the intended scope of this report. On this premise, carrying partner details and notes on mating behaviours in the species listed are believed to be largely undocumented. A few examples of special interest have been discussed in detail elsewhere, and here are presented in brief with reference to the extended accounts. The carrier-partner findings of this report, like those in the first part (Dunn 2000), corroborate the earlier foundational conclusions of Shields and Emmel (1973). Minor adjustments to the first part are pragmatically provided in the appendix.

Mating flights (Nuptial flights)

In most butterfly groups, conjugal couples usually remain settled with closed wings unless disturbed, and "apparently only in the Danainae is there a postnuptial flight" (Scott 1973: 117). Recent Australian evidence suggests however, that 'postnuptial' (nuptial) flights of up to several hundred metres occur in the relict species, *Cressida cressida* (Papilionidae: Troidini) (Orr 1999). Dunn (2000) reported a carrying female repeatedly feeding at flowers, the male suspended as she flew between blossoms. This flight differed from escapist coupled-flights of other species, stimulated by disturbance or perceived intruder approach, by its meandering, leisurely component. Nonetheless, an unseen disturbance may have prompted flight, and carrier decision to feed may have been opportunistic rather than needs driven, yet confoundedly, adults of this genus rarely seek nectar (Orr 1999). Some species mate for several hours or occasionally overnight (Scott 1973), and in *C. cressida* the time taken varies from 17 hours to 3 days or longer (Orr 1999). Perhaps during a lengthy copulation in the drier tropics, the

carrier may require sustenance. In the tropics coupled adults (eg. *Zizina*) placed on flowers will feed opportunistically (this paper). In *C. cressida* the carried partner did not seem an encumbrance to normal foraging activities, even though the female usually carries a heavier male (Orr 1999) – an exception among butterflies. In this paper I document another lengthy (30m) flight in *C. cressida*, and report flights in this species, initiated by either sex seemingly stimulated without intruder disturbance. In contrast, an unusually lengthy (5 or more minutes) circuitous coupled flight in *Hypolimnas bolina* (Nymphalinae) was maintained by the rapid pursuit of several hill-topping, conspecific males, whose intense courting inspections or territorial aggression delayed its landing (Dunn 2004a; this paper).

Methodology

Identification of carriers especially among tiny butterflies is challenging (Warren 1920; Miller & Clench 1968; Dunn 2000). In each case the carrying partner was visually determined from one or more natural or induced flights. In species where the sexes are easily recognised and habitat was suited to likely rediscovery, this was achieved in the field, often stimulated by little more than observer approach.

However, the confines of a butterfly hoop-net were occasionally utilised to confirm carrier recognition. Confinement is a potentially stressful situation for the couple (Miller & Clench 1968) often creative of behavioural anomaly (Shields & Emmel 1973), and remained a last resort, usually after failure to determine the carrier in the field, or based on decision-making from experiential knowledge of the species' habits. Confinement assisted for robust fliers or where their habitat was very dense, or terrain unsuitable for rediscovery of the couple. It also aided for conjugal pairs where close sexual similarity exists, otherwise thwarting recognition in the field. The species accounts clearly state when couples were confined to determine carriers. In a few cases a coupled flight was not achieved, and the probable carrier is suggested from their vertical alignment, a reliable method (Warren 1920; Shields & Emmel, 1973; Dunn 2000, this paper) with few exceptions (Shields & Emmel 1973; Scheermeyer 1999). In other cases species' behaviour and extenuating circumstances thwarted all attempts at carrier sex-determination. For example, the pair of *Tirumala hamata* in Samoa flew and landed repeatedly in the mid-canopy of rainforest. With dappled forest light the sex pouch on the male's hindwing underside could not be seen with the video-cam zoom lens. Its carrier is listed as 'probably male', because the literature evidentially indicates that normally, only the male carries in this group (eg. Shields & Emmel 1973 and references therein; Condron 1974; Scheermeyer 1999; Dunn 2000). In addition, Scott (1973: 117) commented, that during the postnuptial flight in Danainae, "the male always carries the female a short distance".

Carrier determination limitations: partner-assisted landings and departures

The likelihood of passive, partner-assisted landing has been speculated recently in *Taractrocera ina* (Hesperiinae) (Dunn 2003). Video evidence suggests that the passive male sometimes flutters and becomes airborne first, to ease the practicabilities of the heavier females' take off. Although undoubtedly the carrier in flight, the larger female seemed unable to lift a smaller male that remains non-compliant (Dunn 2003). Once in flight the carried male may become limp or stupefy, typical of a carried partner, but sometimes also flutters as the female lands, presumably to prevent impacting the substrate (Dunn 2003). Passive, partner-assisted landing is reported in *Pelopidas lyelli* (Hesperiinae) (this paper), using unaided visual observations. In *P. lyelli*, the carried male sometimes flutters upon landing, even though the female carries him to the substrate. Large butterflies can easily grasp small

substrates upon landing, but smaller skippers may have difficulty given their relative body-weight to wing-area ratio, perhaps stimulating the adaptation of partner-assistance in landing. Dunn (2003: 7) concluded that in hesperiines "a conjugal flight may be highly coordinated and could give a false impression of a male carrier if he [flutters] after she lands." As a limitation to accurate carrier recognition, Dunn (2003) also suggested that assisted-landings could explain unexpected records such as the ostensive male-carrier in *Suniana sunias* (Dunn 2000) given a female-consistent carrier in Hesperiinae elsewhere (Shields and Emmel 1973). In three of the four records accumulated from among the Australian Hesperiinae the carrier was female (Dunn 2000 & this paper; Haywood 2003).

Observations and results

Forty-eight (48) mating observations involving 30 species of butterfly have been compiled (List 1) from my field diaries since my previous collative paper (Dunn 2000). Geographic coverage spans SE Asia from Taiwan through the Australasian region and into central Polynesia from late 1999 to 2004 inclusive, with 27 examples (56%) from the eastern Australian States of Queensland and Victoria. All Australian records fall within known distributions (Braby 2000), but some localities beyond Australia may be new distributional information for the species and countries concerned, except where clarified to the contrary. The country of origin is given in full and bold type for ease of recognition, with exception of The Federated States of Micronesia, space-savingly abbreviated to 'FS Micronesia'. Mating times remain limited, specifying the time of observer discovery, not the time mating commenced or copulative duration (see also Dunn 2000). Times of convenience encounters are based on the recognised time in the country of origin. All daylight saving times used seasonally in eastern Australia have been converted to Australian Eastern Standard Time (AEST) for closer agreement with sun-time. All observations are by the author unless stated otherwise. In terms of standard coupled behaviour, all the copulating adults rested with wings closed, except where stated otherwise, and in all cases the carrier correlated with the uppermost adult upon each landing when pairs selected non-horizontal substrates. Subspecies are generally not mentioned except for a select few of taxonomic intrigue.

List 1. Primary mating observations

Key: carrying partner (CP), male (M), female (F), wet season form (WSF), dry season form (DSF), forewing (FW), hindwing (HW), personal collection (KLDC), Australian Eastern Standard Time (AEST), Western Samoan Time (WST), Yap time (Micronesia)/Chamorro Standard Time (YAPT/ChST), New Caledonia Time (NCT), Vanuatu Time (VUT), Ponape Time (Micronesia) (PONT), Indochina Time (ICT), China Standard Time (CST), Malaysia Time (MYT), relative humidity (RH).

Hesperiidae

Pelopidas lyelli - 15km along Iron Range road from southern turn off from Cape York Peninsula highway, Qld Australia. 7 Jan. 2002, 0930h AEST. CP=F (5 flights). Habitat: savannah woodland. Weather: sunny and hot, 32°C. Mating pair found on grass in sunshine. Couple readily flew short distances (c.10 metres or so), landing up to 1m above ground on tall grass

blades and raised sticks. The larger, upper adult (female) carried the lower, but the lower adult (male) sometimes fluttered to assist her landing (clearly seen using unaided visual obs.). Once netted the couple immediately separated (0945h), preventing a video sequence of their flight to discover the extent of passive-partner assisted take-off and landing. Both sexes were in fresh condition and were preserved as vouchers (KLDC) for identification rigour.

Taractrocera ina - 'Ghost Hill', Urraween (near Pialba), Qld. **Australia.** 24 Jan. 2002 at 0955h AEST. CP=F (several wild flights & six confined flights). Habitat: woodland bordered by vine-thicket and sedgeland. Weather: mostly sunny, 26°C. A detailed description of mating behaviour, including video-evidence of passive-partner assisted take-off, was given in Dunn (2003).

Papilionidae

Cressida cressida - Greys Bay, Bowen Qld., **Australia.** 2 Jan. 2001, 1550h AEST, CP alternated (2 flights). Habitat: pandanus woodland. Weather: 28°C, sunny and windy. On first encounter, female carried male on lengthy flight (about 10m) at about 3m above ground. Couple landed on large tree with female uppermost. Pair then turned around on branch so male became uppermost. Within a minute or two, without direct disturbance other than potentially my approach, male flew carrying female for a lengthy flight (one minute or more) covering 30 or more metres, at similar height above ground. Couple vanished from sight behind trees.

Ornithoptera priamus (ssp. euphorion) - Kuranda Qld., **Australia.** 14 Jan 2001, 1315h AEST CP=F (prob.) (0 flights). Habitat: in commercial butterfly house. Female was uppermost. Couple settled several metres up in foliage in shade. Both sexes grasped substrate.

Pieridae

Catopsilia pomona - Karon Beach, Ko Phuket, Southern **Thailand.** 28 Nov. 2000, 1230h ICT. CP=M (1 flight). Habitat: Guinea grass clearing amongst secondary growth near lowland rainforest about 1km in from beach. Weather: sunny and very hot. [33°C, 59% RH Phuket recording station]. Pair observed during direct lengthy flight at about 2-3m above ground; couple flew robustly and landed on foliage in inaccessible location amongst dense undergrowth. Both WSF adults.

Catopsilia pomona - Wanshaushan at 355m asl, near Kaohsiung (Kaohsiung County), **Taiwan (China),** 10 Jul. 2004, 1500h CST. Habitat: secondary scrubs with vine-thickets. Weather: sunny and hot [31°C, 70% RH at Kaohsiung city]. CP=M (1 flight). Male undertook lengthy coupled flight of 30-40m at 5m above ground. Male DSF, female's seasonal form unclear, yellow beneath – probably WSF.

Catopsilia scylla - Cape York Peninsula: Mt White, Coen, N.Qld., Australia. 6 Jan. 2002, 1310h AEST. CP=M (1 flight). Habitat: adjacent vine thicket at summit. Weather: sunny, very hot, 35°C. Conjugal couple encountered in flight, possibly disturbed by approach of observer then about 2m away. Couple flew one metre before landing on low foliage about 1m above ground. Male carried and settled uppermost. The male's hindwing considerably overlapped

those of the female when settled. Because the sexes are similar and the species is a strong flier, the pair was netted to observe confined flight. Male usually attempted to fly when aroused by tapping and shaking the bag. However, female sometimes also fluttered when severely disturbed, perhaps part of assisted take-off/landing strategies that may be utilised, and observed in other species, such as *P. lyelli* (this paper) and *T. ina* (Dunn 2003), or behavioural anomaly associated with stress conditions (Miller & Clench 1968). In general the trapped couple was reluctant to fly, both adults held firmly to the bag. Couple flew no more than a few centimetres; again male carried. The pair was preserved (KLDC); both adults were fresh.

Belenois java (ssp. *peristhene*) - Kuenda Beach, Nouville, **New Caledonia**. 5 Feb 2004, 1555h NCT. CP=M (3 flights). Habitat: within dense, dry vine-thicket. Weather: sunny/overcast. Male consistently carried female; flight distances ranged from 5-10m to locate a new landing site. Couple settled variably from 1-2m above ground on low leaves. Male consistently settled uppermost, female sometimes hanging limply, with wings almost fully enclosed within male's hindwings. Male appeared in slightly worn condition, the female seemed fresh.

Pieris rapae - Upper Beaconsfield Vic. **Australia.** 18 Feb. 2001, 0945h AEST. CP=M (6 flights). Habitat: eucalypt woodland at 190m a.s.l. near residential area. Weather: sunny, c.25°C. Pair first encountered flying less than a metre above ground over soft grasses above a weedy roadside drain. Male settled on sunlit grass blades. Female hung limply from male's abdomen. Her legs were folded below thorax, not grasping substrate. Both adults held wings closed. An additional male repeatedly attempted to court the copulating couple, and caused male to flap wings in an attempt to become airborne or as a signalling display. Intruding male and my repeated approach disturbed couple, which flew about six times, travelling small distances of 1 to 4 metres before settling again. Couple settled on herbs and grasses within 10cm of ground. Male was slightly worn, female fresh.

P. rapae - Frankston Vic. **Australia.** 5 Mar. 2002, 1540h AEST. CP=M (5 flights). Habitat: residential parkland. Weather: sunny, 32°C. Couple encountered in flight. Couple landed in shade on leaf of *Gahnia sieberiana* (Cyperaceae) at 1.5m above ground. Male grasped underside of sedge leaf, female hung vertically from male with legs tucked up. Female's hindwings ovelapped significantly those of male, bisecting midway along FW costa of male. Flights were short, sometimes circuitous, variably from 1-8 metres from original landing site and rising up to 3m above ground. Upon landing in sunshine male fluttered briefly, female remained limp. Male also fluttered briefly as he crawled along leaf a centimetre or two, held wings in wide 'V' then slowly closed them, thereafter usually keeping them closed. Female never opened wings. Couple also landed on other low plants at heights of 1-1.5m above ground. When couple flew into grassy lawn area the male carrier sharply U-turned to land on the small shrubs from whence he had come. *Gahnia* was selected as substrate on three of the five landings. Both sexes: fresh condition.

P. rapae - Croyden Vic. **Australia.** 29 Nov. 2004, 1420h AEST. CP=M (3 flights). Habitat: residential garden. Weather: 28°C, hazy. Couple encountered in laboured flight, about 2m above ground, travelling about 10m to land. Settled with male vertically uppermost on sunlit side of 'Tarata' (*Pittosporum variegatum*) - a variegated-leaf tall shrub favoured by adult Cabbage butterflies as a resting site. Smaller, fresh, cream-colored female hung limply from male abdomen with wings tightly closed partly inside males' HWs. Male held wings above body but marginally opened. Manually swaying shrub readily promoted two further flights with male carrying female about two or three metres to land a metre higher in shrub each time.

On third landing near top of shrub (about 4m above ground) couple seemed reluctant to fly and when eventually roused, departed unseen.

Nymphalidae

Elymnias hypermnestra (ssp. *tiuctoria*) - Tonsai Bay, Ko Phi Phi Don, southern Thailand. 5 Dec. 2000, 1215h ICT. CP=F (6 flights). Habitat: clearing adjacent rainforest about 100m in from shore. Weather: sunny and hot [33°C, 59% RH at Phuket recording station]. Male slightly worn. Female of danaine form (tiger-mimic), worn with chipped hindwings (possibly a second or subsequent mating). Couple wary and readily flew when approached to within 1-2m. Female consistently carried, and always settled uppermost. Both adults held wings closed, female's hindwings overlapped the males. Pair settled quickly, about 0.3-0.4m above ground, on the leaves of yam-like plant, and also on grass protruding amongst these plants. Coupled flights were low to ground (up to 1m in height) and direct, sometimes extending about 10m.

Geitoneura klugii - Churchill National Park, near Dandenong Vic. Australia. 19 Jan. 2004, 1149h AEST. Habitat: eucalypt woodland with understory of *Microlaena* and other soft grasses at 100m a.s.l. Weather: sunny, light breeze, warm, 25°C. Couple not wary. Both sexes fresh. CP=F (5 flights). Couple discovered at rest on sunlit leaf litter on ground. Female wings held in basking stance, male with wings closed. Couple disturbed into flight on initial approach, and flew 3m to resettle on a sunlit fallen branch. Female held wings closed and male lay horizontally on the ground with tucked legs, feigning death. His HW camouflaged amongst the leaf litter. Couple rotated 180 degrees. Couple then disturbed, and female flew 5m, landing uppermost on shaded side of tree trunk, 1m above ground. Both sexes held wings closed, male hung limply. Couple disturbed again into flight, and female landed the couple on shaded side of new trunk 2m above ground. Stance same, with male hanging limply. In flight female elevated to 3m above ground covering 4-5m distance and landed again on shaded side of another trunk, at 2m above ground. Male was closely examined each time, and whilst feigning death his wings could be gently prised open using pencil point to reveal his sex brand, without alarming him. Pencil-point contact to male's legs induced no movement. Pencil contact to legs of female however, caused lateral (side step) movement of female. Tactile contact with female's antennal tip promoted flights each time. On one occasion within seconds of couple's departure a new male arrived which continuously patrolled site of couples' former landing for 1-2 minutes. He hovered and flew within centimetres of the bark covering a radius of 50cm about where the couple had, moments earlier, been settled. Still enticed, he then perched on the trunk 30cm away and faced the site – a behaviour probably pheromonally influenced.

Heteronympha merope - Churchill National Park, near Dandenong, Vic. Australia. 17 Dec. 2002. Weather: sunny, still, hot, 29°C. Habitat: open forest. 1st mating pair: at 1025h AEST. CP=F (1 flight). Habitat: eucalypt woodland. 2nd mating pair: at 1140h (AEST.) CP=F (4 flights). Both couples were very wary. Details of mating behaviour were provided in Dunn (2004).

Hypolimnas bolina - Lelu Hill summit, Lelu Is., Kosrae Island, FS Micronesia. 3 Jul. 2003, 0945-1000h PONT. Habitat: secondary scrub, sunny, very hot and still conditions. CP=F (5 flights). Two settled mating pairs observed simultaneously on summit at 0945h, situated on same densely foliaged tree, about 3m above ground and about 1.5m away from each other. 1st mating pair: female uppermost; 2nd mating pair: same, but on one occasion adults aligned more or less horizontally. Both sexes of both pairs settled with closed

wings, and on south-easterly, sunny-side of tree. Females in fresh condition, and of the orange form (similar to those illustrated from eastern Australia designated form 'E' in Braby 2000). Both males slightly worn with HW underside white medial 'band' reduced to a central spot separated from the smaller costal HW spot - typical of many Kosraean males. When disturbed, female carried male variably from 1-30 metres before settling. Female consistently carried in both pairs. At 1000h (PONT) a disturbed couple flew circuitously about summit with several males in pursuit. This multiple male attention promoted a very lengthy nuptial flight, lasting about 5 minutes (timed for at least 3 minutes sometime after flight had commenced).

Junonia orithya - Greys Bay, Bowen Qld, **Australia.** 2 Jan. 2001, 1525h AEST. CP=F (5 flights). Female, WSF, in fresh condition; male DSF, a very worn, old adult. Habitat: pandanus woodland. Weather: sunny and windy, 28°C. Female settled on low herbs in full sunshine - wings held widely apart. Male remained with wings closed. Both sexes grasped substrate.

Junonia villida - Groper Creek, SW of Home Hill, Qld., Australia. 3 Jan. 2001, 1010h AEST. CP=F (3 flights). Habitat: pandanus woodland. Weather: sunny and hot, 29°C. Couple settled on low trees about 2m above ground. Both sexes grasped substrate. Both sexes WSF and in fresh condition.

Vindula arsinoe - Kuranda Qld. **Australia.** 14 Jan. 2001, 1300h AEST. CP=F (several flights). Habitat: in commercial butterfly house. Pair settled on low foliage always with female uppermost. Both sexes grasped substrate.

Danaus chrysippus - Granite Creek, south of Miriam Vale, Qld., Australia. 30 Dec. 2001, 1320h AEST. CP=M (3 flights). Habitat: open woodland with abundant ground cover of *Asclepias* spp. Weather: sunny, very hot, c.34°C. Pair encountered in flight. Rested variably 1-2m above ground, on protruding twigs of trees and shrubs. When settled female hung limply from male, both with closed wings. Couple wary, readily flew when approached within two metres. Flights lengthy, up to 50m traversed before resettling.

Danaus chrysippus - 1km NE of Littlemore, Qld., Australia. 19 Jan. 2002. Habitat: beside dry creek in open woodland with an abundant ground cover of *Asclepias* spp. Weather: sunny, c.28°C. **1st mating pair:** at 1505h AEST. CP=M (5 flights). Couple wary and readily flew when approached. After each flight couple rested on low erect, coarse grasses and upright sticks up to about 1m above ground. Some flights were time-lengthy continuing for one minute or more (timed), but were often circuitous and meandering - the couple remained close to the original resting site, settling usually only 10-20m away. On landing female often hung limply from male abdomen, but sometimes grasped substrate. Male worn with chipped hind wings, female in fresh condition. **2nd mating pair:** at 1520h AEST. CP=M (1 flight). A recognisably different pair was observed 15 minutes later some 50m away. Both sexes in good condition. Couple was lost from view after its second flight.

Tirumala hamata - Cape Niuato'l, O Le Pupu-Pu'e National Park, Upolu Island, Samoa. 17 Feb. 2003, 1300h WST. CP= undet. (several flights). Habitat: dense rainforest. Weather: sunny. Mating pair observed flying adjacent rainforest margin Couple undertook extended flights at about 7m above ground, settling on vegetation at same height. Disturbance to foliage readily promoted flights. Carrier remained unconfirmed - couple never descended low enough to see HW sex-brand. A male carrier agrees with the familial trend and is to be expected.

Idea leuconoe - South west of Batu Ferringhi, Penang, Malaysia, 2 Nov. 1999. c.1400-1500h MYT. CP=M (prob.) (0 flights). Habitat: in commercial butterfly enclosure 'Penang Butterfly Park'. Couple vertically aligned. Male was smaller and uppermost. Both sexes clasped large leaves near ground level. Larger adult (female) observed irregularly partially opening and partially closing wings and adjusting foothold. Male remained motionless with wings closed. Carrier determination is inferred on circumstantiality of alignment, and agrees with the sub-familial findings of male consistency (Table 2). (Subspecies remains undet. - potentially of Indonesian stock; seemingly not *chersonesia* from Malaysia).

Euploea core - 'Ghost Hill', Urraween (near Pialba), Qld., Australia. 21 Jan. 2001, 1507h AEST. CP=M (1 flight), Habitat: remnant roadside vine thicket in residential area adjacent unimproved lot. Weather: hot and sunny. Pair encountered flying about 2m above ground in sunshine. Because of close similarity of sexes, pair was netted and pinioned to examine for sex-brand. Male confirmed as carrier, but pair separated during examination. Both sexes slightly worn. Many *E. core* adults were flying in this localised area, possibly a remnant of an over-wintering cluster.

E. core (ssp. *corinna*) - Magenta, Noumea, New Caledonia., 1 Feb 2004, 1430h NCT. CP=M (5 flights). Habitat: residential garden. Weather: hot and sunny. Male landed uppermost each time. Both sexes grasped substrate, with wings closed. (Although Holloway & Peters (1976) do not list this species from New Caledonia, adults were common in suburban Noumea during my visit in January and February, occasionally seen feeding at buddleia and other garden flowers. The male sex-brand confirmed its identification, and adult patterns closely resembled the Australian subspecies under which I have included them).

Euploea sylvester - 5km east of Chillagoe N.Qld. Australia. 12 Jan. 2002, 1513h AEST. CP=M (>5 flights). Habitat: vine thicket on low hills in woodland. Weather: sunny and very hot, 34°C. Pair encountered in flight about 2m above ground. Couple flew variably 1-3m above ground. Some flights were lengthy and meandering, up to 15m or more covered, and selection of rest site on trees was delayed, with adults fluttering above protruding twigs before eventually choosing a landing platform. Both adults held wings closed when settled, and grasped substrate. Couple was wary of approach of observer and readily took to flight. They eventually flew high over the vine canopy (>5m) and were lost from view and not rediscovered. Both sexes were in fresh condition.

Euploea sp. (*?sylvester*) - Kenting National Forest Reserve, Kenting, Taiwan (China). 12 Jul. 2004, 1310h CST. Habitat: rainforest margin near snakeweed (*Stachytarpheta*) flowers. Weather: sunny, and hot. CP=M (2 flights). Mating pair encountered in flight: Male fresh condition: female slightly smaller, fresh condition. Couple settled on foliage 2-3m above ground. Female remained limply suspended from males' abdomen. Coupled flights were lengthy, covering 10-15m distance.

Euploea tulliolus - La Yahoue River Falls (150m asl.), 2km north of Boulton, Noumea, New Caledonia. 2 Feb 2004, 1225h-1300h NCT. Habitat: beneath rainforest canopy. Weather: sunny. **1st mating pair:** at 1225h NCT. CP=M. One flight observed in mid canopy, aided by video-camera zoom lens. Carrier determined based on landing positions. Male clearly uppermost, holding extremity of foliage, with female daggling from his abdomen with her legs tucked up in feigning death pose. Both sexes belong to the normal form of *tulliolus*. Male appeared a paler brown suggesting older age, the smaller female appeared fresh. **2nd mating pair:** at 1240h NCT. CP=M (one flight observed mid canopy and carrier determined from male landing uppermost on foliage in trees - female

dangling, not holding substrate). Female was a dark form of *tulliolus* (form *forsteri*?) (i.e FW underside postmedian markings reduced). Older male was also a dark form. Male lacked obvious FW underside patterns, and had obscure HW underside patterns. 3rd mating pair: at c.1300h NCT. CP not determined (one flight observed). Sex of uppermost adult not confirmed, but was likely to be male in accordance with the familial carrier trend. Adults settled in mid canopy and could not be seen adequately in the filtered sunlight or dislodged by projectiles. Both sexes appeared to be the normal form.

Lycaenidae

Arhopala micale - Wulguru, near Townsville, Qld. Australia. 5 Jan 2001, 1755h AEST. CP= F (prob.) (0 flights). Pair found settled 1.5m above ground, in deep shade, on upper leaf surface of palm frond (*Chamcodorea* sp.) in residential garden. Both sexes with wings closed during coitus, and both firmly grasped leaf-substrate. Female was uppermost (data used to infer the carrier in absence of a flight), very under-sized and slightly worn. Male, normal sized, and worn. Pair could not be enticed to fly and separated immediately when disturbed. Male departed first. Female remained on palm for a few seconds longer. A flight may not have occurred because of the female's abnormally small size (0.6x normal), perhaps being unable to carry a heavier male.

Nacaduba berenice - Fixter Park, Toogoom Qld. Australia. 23 Jan. 2002, 1407h AEST. CP=M (5 flights). Habitat: shore vine-scrub in woodland. Weather: overcast, 32°C. A detailed description of mating behaviour was given in Dunn (2002).

Nacaduba cyanea - Ella Bay National Park, Qld. Australia. 3 Jan. 2002, 1245h AEST. CP=M (5 flights) Habitat: shaded understorey of lowland rainforest. Temp. 29°C. A detailed description of mating behaviour was given in Dunn (2002).

Nacaduba dyopa - 1760 Lava Flow View Point (unmarked road crest), Savaii Island, Samoa. 14 Feb. 2003, 1255h WST. CP=F (1 flight). Habitat: post lava flow successional scrubland. Female (smaller and paler) carried male and settled uppermost, on leaves of low bush 1-2m above ground. Females' legs were very active and seemed agitated, possibly disturbed by large ants wandering on stems and leaves. Couple then rotated clockwise 180 degrees on leaf, reversing alignment but within seconds rotated clockwise another 180 degrees. Male steered this rotation a further 45 degrees causing similar response in female, but female then steered 45 degrees anticlockwise finally aligning and resting with female uppermost facing raised petiole. Male abdominal pulsations seen. Couple not rediscovered after second flight. Both adults fresh conditioned. These likely ant-stimulated rotations did not seem to be a conjugal 'dance' (compare Atkins 1995: 56).

Leptotes plinius - Port Vila, Efate, Vanuatu. 20 Feb 2004, 1022h VUT. Habitat: central business district at street-side flower encasement. Weather: sunny. CP= F (prob.) (0 flights). Pair found resting on leaf of *Plumbago* sp. Whilst copulating female fanned wings briefly - an unusual coital behaviour, and potentially a refusal response to a visually detected approaching male. The inspecting male then landed adjacent couple on same leaf and fanned his wings at mating pair; the intrusive male then departed. Smaller female was clearly uppermost on leaf substrate strongly implying a female carrier, despite male being notably larger and perhaps difficult to uplift. To avoid escape, net bag was carefully placed over couple and substrate to assist carrier determination. Pair separated

immediately when disturbed, and male flew higher into bag apex. Although Braby (2000) does not include Vanuatu in this species' world distribution - it is well known from Efate and nearby islands (Samson 1983, and recently Tennent 2004).

Tarucus sp. (*?callinara* or *?nara*) - Vientiane, **Laos.** 4 Jul. 2002, 1750h ICT. Habitat: maize weeds adjacent Mekong River. Weather: overcast, c.32°C. CP=F (3 flights). Coupled flights occurred at heights of about 1m above ground, with female consistently landing uppermost on substrate - a type of 'windmill grass'. (Male upperside was blue, like that of the male of *Leptotes plinius* in Australia, but the female had distinctive pale central spot on FW upperside, characters which may assist future identification to species).

Zizula hylax - Apia Harbour, Upolu Island, **Samoa.** 10 Feb. 2003 at 1115h WST. CP=M (2 flights). Habitat: parkland near lake on reclaimed land. Weather: sunny and hot, 28°C. Male fresh conditioned, marginally larger with unusually prominent HW patterns, female slightly worn. Male's muscular abdominal contractions were visible, but otherwise couple rested motionless, and was not disturbed by close inspection or handling of substrate. The larger adult was seen to be the carrier and settled uppermost. These fine abdominal contractions recorded on video clarified his sex, contradictive to my earlier field identification as 'female'.

Zizina otis - Chamorro Bay, Colonia, Yap Island, FS Micronesia. 4 Jul 2003. Habitat: shore area - weedlands. CP=M (consistently in all three couples). 1st mating pair: at 1440h YAPT/ChST. Weather: hot and overcast. Male (larger) carried consistently (5 flights observed). Pair undertook low-to-ground, short flights covering variably 1-2m. Male, larger and slightly worn, and female, fresh conditioned. Male settled uppermost, and on one occasion female was limply suspended from male. Couple was placed on a flower of *Tridax procumbens* (Asteraceae) and female commenced feeding. 2nd mating pair: at 1645h YAPT/ChST. Weather: overcast. Larger male carried female consistently (3 flights observed). Male slightly worn, female worn. Pair separated upon being handled. 3rd mating pair: at 1725h YAPT/ChST. Weather: overcast. Male carried consistently (3 flights). Both sexes confirmed by careful handling (and did not separate) as undersides were less revealing in this couple because female was worn. Male condition not recorded.

Zizina labradus - Tamboritha Saddle, near Licola, Vic. **Australia.** 30 Jan. 1996, c.1300-1440h AEST. Habitat: alpine eucalypt forest at 1280m a.s.l. Weather: sunny. Both sexes with wings closed. CP not determined, as couple was not relocated after first flight. Pair encountered by the late W.N.B. Quick on joint trip with author.

Z. labradus - Churchill National Park, Vic. **Australia.** 11 Dec. 2000, 1200h AEST. CP= either (CP=F, 2 flights & CP=M, 2 flights). Habitat: heath-woodland. Weather: sunny and hot. Couple found settled in full sunshine on foliage of a *Leptospermum* sp. prob. *juniperinum* (Myrtaceae) at about 1.5m above ground. Both were in worn condition, and had settled with wings closed. Couple was encouraged to fly twice and female carried on both occasions. Couple disappeared from view behind dense thickets on its next flight. After searching the general area for several minutes, it was rediscovered (presumed to be the same pair) about 10 metres away. The couple was once again induced to fly, but instead, the male carried the female for the next two flights. Sexes were confirmed by careful handling on each occasion.

Z. labradus - Adjacent Hamilton Reserve, Upper Beaconsfield, Vic. **Australia.** 11 Dec. 2003, 1325h AEST. CP=M (6 flights) Weather: Sunny, hot, 28°C. Habitat: grassy road reserve, at 220m

a.s.l. Female hung limply from male. Couple settled on flattened grass leaves and stems, usually horizontally, or with male slightly uppermost. Conjugal flights traversed up to 10m, each about 1m above ground. Male carried consistently, his upper-side coloring was recognisable during each flight. Male slightly worn; slightly larger female very worn - probably a second or subsequent mating for her.

Z. labradus - Dandenong Creek, Dandenong Vic. Australia. 14 April 2004, 1310h AEST. CP=M (prob.) (1 flights). Weather: Sunny, 31°C. Habitat: dry grassland adjacent relict scrubby woodland. Pair flew low to ground, and landed, with closed wings on sunlit matted dry grass. Larger, chipped and worn male was slightly elevated in position, suggesting the uppermost partner and hence circumstantially the carrier. Male's abdomen pulsated against copulating female whose abdomen was curved upwards. Female was fresh, but small-sized. Her darker underwing patterns distinguished her sex immediately and later in-hand examination confirmed it. A small bag net held directly over couple promoted immediate separation and independent flight, before the carrier was confirmed beyond reasonable doubt.

Z. labradus - Lynchs Beach, Alva Qld. Australia. 3 Jan. 2001, 1300h AEST. CP=F (3 flights). Habitat: shore scrubland. Weather: sunny, 29°C, with strong easterly wind. Couple rested on lawn grass, male hung limply from female's abdomen with legs tucked up, not grasping substrate. Pair remained in full sunshine, both sexes with wings closed. Female in worn and male very worn condition, suggesting a subsequent mating for each.

Z. labradus - Asau Harbour, Savaii Island, Samoa. 14 Feb 2003, 1330h WST CP=M (1 flight). Habitat: dominated by pinkish-red flowered pea plants growing amongst other shore weeds. Weather: sunny and hot. Mating pair settled on weed leaf, 1m above ground. Male (larger adult) carried female in flight. Smaller female remained limply suspended from male's abdomen on leaf edge, not grasping substrate. Female later crawled underneath leaf edge, remaining in coitus, with male positioned on leaf upper surface. Male intermittently flicked wings (revealing lilac wing coloring and sex) as couple continuously rotated on leaf edge and leaf tip. Repeated male wing flicking perhaps occurred in response to an earlier polyommatine inspection. There were numerous polyommatines flying about nearby pea plants, and on one occasion a male *Euchrysops cnejus* momentarily inspected couple – captured on video. Alternatively, but less likely, the wing flicking was in response to a virtual image in the video-camera lens, mistaken as an inspecting male (see Dunn 2003a for discussion). Male slightly worn; female fresh conditioned. These likely butterfly-intruder stimulated rotations did not seem to be a conjugal 'dance' (compare Atkins' 1995 account for *Candalides heathi*).

Mating Times

The 48 matings are summarised along with those from previous collative works for ease of comparison (Table 2). Encounter times for mating pairs have been grouped into two-hour allocations (see Table 1) to better approximate time of mating commencement. Numbers attached to a time period indicate replications for that period. Where a time period rather than an exact time was recorded (one record) the earliest time period involved was allocated. For Australian records, all eastern daylight saving times have been converted to Australian Eastern Standard Time prior to grouping. Overseas records are at the times in those countries and grouped to the appropriate period. Hyphenated time periods indicate records in consecutive periods.

Data conclusions

The new carrying partner details agree well with earlier results, some groups suggesting consistency and in a few, a tendency toward carrier irregularity (Table 2). Shields and Emmel (1973) reported a male bias among the Polyommatinae. To quantitatively determine proportionality, a large random sample is required, each couple flight-tested multiple and equal times under similar, unstressed conditions – ideally, free range with minimal interference. Carrier-sex ratios calculated for *Zizina labradus*, the genus *Zizina*, and the subfamily Polyommatinae are based on convenience samples (ie. incidentally encounter without determined or planned searching of sites of oviposition, or favoured habitats used for mate location) and are limited by uncontrolled multiple factors.

Two methods can be used to determine carrier ratios, for groups where alternation is known. **Method 1**: involves counting all flights irrespective of the number of couples involved. As a limitation the ratio is slanted by an irregular number of flights sampled per couple, and imbeds a presupposition that individual couples select carriers randomly for each flight, which may not be true. Hence, unbalanced replications in any one potentially carrier-consistent couple seriously skews results in favour of the carrier sex of the over-sampled couple. **Method 2**: involves tallying a single flight per consistent carrier couple and recording two flights where both sexes carried (one couple only). This eliminates bias from the varied number of replicate flights. Scoring twice where alternation occurred, once for each sex to represent this variation, eliminates the possibility that they were actually separate couples. Limitation: it imbeds an assumption that couples are normally carriers consistent, which largely seems true (this paper). Yet, of interest, a single example of natural carrier alternation is also now apparent in the Australian Papilioninae (Dunn 2000, this paper) but more observations are needed to suggest any trends in this group towards regular, within-couple alternation of carriers. Indeed, Orr (1999) has reported female carrier consistency in *C. cressida* so this solitary observation may be exceptional.

***Zizina*:** In *Z. labradus*, an abundant polyommatine species for which larger numbers of mating observations have accumulated, carrier sex apparently varies both within and between couples (Dunn 2000, this paper). Circumstantial evidence of carrier alternation observed in one couple hinges on the assumption that it was the same couple rediscovered after it was temporarily lost. At oviposition sites multiple localised matings are often found simultaneously (Condron 1974; Dunn 2000; this paper) providing an alternative conclusion. Method 1: combining the earlier flight records (n=9 flights, n=9 couples) (Dunn 2000) with the 15 new flight records (n=5 couples) (this paper) totals to 24 flights (n=14 couples). Carriers involved 16 males to 8 females (n=24 flights) providing a 2:1 male-female carrier-ratio, in similar agreement with earlier tentative findings (Dunn 2000). Using method 2 the same ratio (but n= 15 rather than 14 flights because of couple alternation) is obtained. For this genus the cumulative (Dunn 2000 & this paper) carrier male to female ratio becomes 27:8 simplifying to 3.4: 1 (method 1) and 13 males: 5 females simplifying to 2.6: 1 (method 2)

Polyommatinae: The number of flights used to determine carriers in Dunn (2000) was not stated and is assumed as one for each couple, but probably involved replications for some. Combining data from both papers (Dunn 2000 & this paper) the M:F carrier-sex ratio, based on the total documented flights and alignments (equally weighted) (method 1), is 43:18 (n=61). This simplifies to about 2.4:1 for the subfamily Polyommatinae but begs carrier inconsistency as normal (elimination of the alignment results (n=3) does not modify this ratio from 2.4:1). Using method 2, Dunn (2000) provides a ratio of 10:8 (including one male carrier derived from alignment) which simplified to an approximately equal male to female carrier-ratio for the Polyommatinae (see Table 2), but the sample size was small (n=18). Including the results from this paper (part II) a 20:13 male-biased ratio (1.5:1, n=33 including 3 alignments) is obtained (method 2). This lower ratio begs carrier consistency as the norm, which is supported with current findings (this paper), and is not slanted by irregular replications potentially skewing in favour of the carrier sex of couples which had higher numbers of flight counts recorded. However, an averaged then simplified ratio of about 2:1 is conservatively suggested for the subfamily Polyommatinae (Table 2) in the Asia-Pacific region until more rigorous data justifying a differing male carrier-bias is evident.

Table 1 – Time Periods

0601 – 0800h AEST	early morning (EM)
0801 – 1000h AEST	mid morning (MM)
1001 – 1200h AEST	late morning (LM)
1201 – 1400h AEST	early afternoon (EA)
1401 – 1600h AEST	mid afternoon (MA)
1601 – 1800h AEST	late afternoon (LA)

Appendix: Corrections and adjustments to Dunn (2000)

- * [see Table 2] I reported having not documented the uppermost sex in my field notes for the *Chaetocneme denitza* near Townsville, Australia (p.67). I since remember grasping a leaf tip of *Senna surattensis* (Caesalpiniaceae) ('Cassia') and lifting it upward to expose the undersurface

and unexpectedly, the coupled adults. The male was closest to my thumb and forefinger (1cm away). Remarkably, neither adult was disturbed by this close substrate contact. The mating pair seemed oblivious and even when captured in a bottle, crawled in and did not fly – unusual behaviour for coupled butterflies (Shields & Emmel 1973). Peeling the leaf upward exposed both sexes, making the male look uppermost interfering with initial recall. When the leaf hung downwards the larger female would have been uppermost, being closest to the petiole, and hence the probable carrier should the couple fly. In agreement, Shields & Emmel (1973) reported the female as the consistent carrier in New World Pyrginae.

- ** [see Table 2] My comment on the apparent absence of carrier records for the Australian plate subfamily, Trapezitinae (p.63 para 1 & para 4) overlooked three reports on two species in NSW (Atkins 1988, 1997, 1999). Nonetheless, I concord with Atkins (1999) who remarked based on his experiential knowledge, that mating in this subfamily is not often observed. Atkins' provided the following data: *Trapezites eliena* - mating pair found at 1345h (EA) NSW Australia. CP not determined; uppermost adult not stated (Atkins 1997); *Toxidia peron* - CP=F (3 flights), 1344h (EA) NSW Australia (Atkins 1988); and *Toxidia peron*. CP=F [presumably 1 flight] 1130h. (LM) NSW Australia (Atkins 1999). On both occasions the *T. peron* couples were reluctant to fly and when forced, flew but a few metres.

- "*Chilades ?pandava*" (p.68) from Manilla, Philippines expresses uncertainty over the species identification. Based on re-examination of the video-recorded images and subsequent experiential knowledge of identification of Asian species, I am confident the identification is *C. pandava* in this instance.

- In list 2 (p.69) under *H. penelope* the bracketed comment "third pair prob. female" should have read 'first pair prob. female'.

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References

Atkins, A. 1988. A note on the mating behaviour of Australian Trapezitine skipper butterflies. *Victorian Entomologist* 18(1): 7

Atkins, A. 1995. Biological interactions of some Hesperiidae and Lycaenidae in central and northern New South Wales. *Victorian Entomologist* 25(3): 55-56.

Atkins, A. 1997. Biological and distributional notes for some southern Australian skipper butterflies. *Victorian Entomologist* 27(1): 3-4.

Atkins, A. 1999. Seasonal occurrence, biology and distribution records of some butterflies from the Hunter Region of New South Wales. *Victorian Entomologist* 29(6): 102-104.

Braby, M.F. 2000. *Butterflies of Australia: Their identification, biology and distribution.* (Vol. I & II). CSIRO Publishing, Collingwood Vic.

Condron, B. 1974. Observations on the pairing of *Danaus plexippus*, the Wanderer or Monarch butterfly. *Victorian Entomologist* 4(3): 37.

Dunn, K.L. 2000. Carrying pair behavior and mating times in some Indo-Australian butterflies and day-flying moths. *Victorian Entomologist* 30(5): 63-70.

Dunn, K.L. 2002. Courtship, mating and oviposition behavior of *Nacaduba* Moore in Queensland (Lycaenidae: Polyommatinae). *Victorian Entomologist* 32(2): 19-23.

Dunn, K.L. 2003. Aspects of mating behavior of *Taractrocera ina* Waterhouse (Lepidoptera: Hesperiidae: Hesperiinae) in Queensland. *Victorian Entomologist* 33(1): 4-7.

Dunn, K.L. 2003a. Same sex courtship of *Zizina otis* (Fabricius) in Luzon, Philippines (Lepidoptera: Lycaenidae: Polyommatinae). *Victorian Entomologist* 33(3): 42-49.

Dunn, K.L. 2004. Courtship refusal and mating behavior in *Heteronympha merope* (Fabricius) in Victoria (Lepidoptera: Nymphalidae: Satyrinae). *Victorian Entomologist* 34(2): 17-22.

Dunn, K.L. 2004a. [No title] *In* Minutes of the General Meeting 20 August 2004. *Victorian Entomologist* 34(5): 50.

Haywood, B.T. 2003. Garden observations of *Taractrocera papyria* (Hesperiidae) (including coupling) in the Lower South East Region of South Australia. *Victorian Entomologist* 33(4): 56-59.

Holloway, J.D. & Peters, J.V. 1976. The butterflies of New Caledonia and the Loyalty Islands. *J. Nat. Hist.*10: 273-318.

Miller, L.D. & Clench, H.K. 1968. Some aspects of mating behavior in butterflies. *J. Lepid. Soc.* 22: 125-132.

Orr, A.G. 1999. The Big Greasy, *Cressida cressida* (Papilionidae). *Monographs on Australian Lepidoptera* 6: 115-134.

Samson, C. 1983. Butterflies (Lepidoptera: Rhopalocera) of Vanuatu. *Naika (Journal of the Vanuatu Natural Science Society)* 10: 2-6.

Scheermeyer, E. 1999. The Crows, *Euploea* species, with notes on the Blue Tiger, *Tirumala hamata* (Nymphalidae: Danainae). *Monographs on Australian Lepidoptera* 6: 191-216.

Shields, O. and Emmel, J.F. 1973. A review of carrying pair behavior and mating times in butterflies. *Journ. Res. Lep.* 12: 25-64.

Scott, J.A. 1973. Mating of butterflies. *Journ. Res. Lep.* 11: 99-127.

Tennent, W.J. 2004. The butterflies of Vanuatu, with notes on their biogeography (Lepidoptera: Hesperioidea, Papilionoidea). *Nachr. Entomol. Ver. Apollo, N.F.* 25(1/2): 79-96.

Warren, B.C.S. 1920. Some records of, and observations on, the flying-habit of butterflies when paired. *Entomologist's Record* 32: 218-223.

Table 2 Subfamily / Subfamily	Consistent Carrier: Shields & Emmel 1973:	Consistent Carrier: Dunn 2000	Consistent Carrier: this paper:	Mating Times: Shields & Emmel 1973	Mating Times: Dunn 2000	Mating times: this paper	Number of pairs: Dunn 2000	Number of pairs: this paper
Pyrginae	Female	Not det **[F*]**	**No data**	MM-LA	EM	**no data**	1	**no data**
Coeliadinae	No data	No data	**No data**	No data	No data	**no data**	0	**no data**
Hesperiinae	Female	Male	**Female**	MM-MA	MA	**MM**	1	**2**
Trapezitinae	No data	No data **[F**]**	**No data**	No data	No data **[LM-EA**]**	**no data**	0	**no data**
Papilioninae	Female	F (mostly)	**F (mostly)**	MM-LA	LA	**EA-MA**	3	**2**
Parnassiinae	Female	No data	**No data**	No data	No data	**no data**	0	**no data**
Coliadinae	Male	Male	**Male**	MM-LA	MA-LA	**EA2-MA**	2	**3**
Pierinae	Male	Male	**Male**	EM-LA	EA-MA	**MM & MA3**	4	**4**
Amathusiinae	No data	No data	**No data**	No data	No data	**no data**	0	**no data**
Satyrinae	Female (mostly)	Female	**Female**	EM-LA	EA-MA	**LM3-EA**	>12	**4**
Nymphalinae	Either (F bias)	Not det	**Female**	MM-LA	EA	**MM2-LM & MA**	**1**	**4**
Heliconiinae	(included above)	No data	**Female**	(included above)	No data	**EA**	0	**1**
Acraeinae	Either	No data	**No data**	No data	No data	**no data**	0	**no data**
Libytheinae	Not determined	No data	**No data**	Evening	No data	**no data**	0	**no data**
Danainae	Male	Male	**Male**	EM, EA-LA	EA-LA	**EA7-MA5**	>8	**12**
Lycaeninae	Either (M bias)	No data	**No data**	MM-MA	No data	**no data**	0	**no data**
Theclinae	Female	Female	**Female**	MM-EA, LA	LA	**LA**	1	**1**
Polyommatinae	Either (M bias)	Either (equally)	**Either (M bias 2:1)**	MM-MA	MM-MA	**LM3-EA6-MA3-LA3**	18	**15**
Riodininae	Female	No data	**No data**	EA-MA	No data	**No data**	0	**0**

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